

Perspective Shadow Maps

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revés

rendering & virtual environments with sound

shadow maps

- Williams, Siggraph '78
 - render scene from light source
 - shadowing by depth comparison



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shadow map aliasing

- prone to aliasing when zooming into shadow boundaries



single shadow map pixel

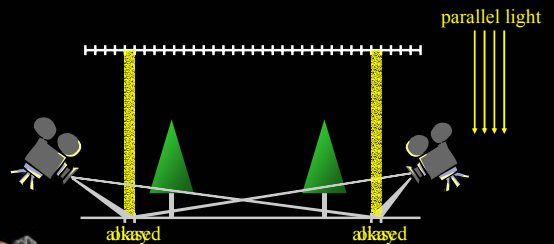


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shadow map aliasing

- perspective aliasing

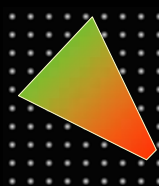
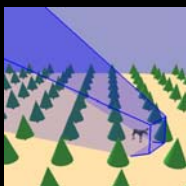


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shadow map aliasing

- perspective aliasing
 - smooth transition

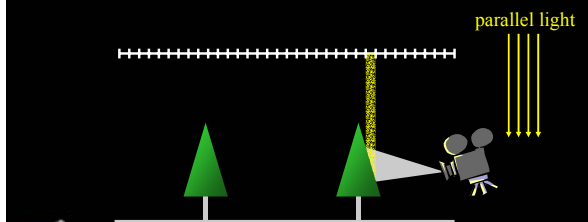


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shadow map aliasing

- projection aliasing

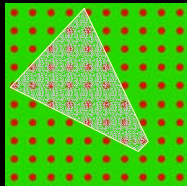
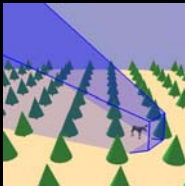


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shadow map aliasing

- projection aliasing
 - very local



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previous work

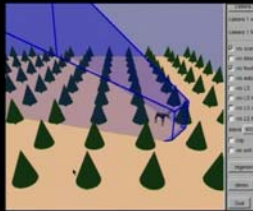
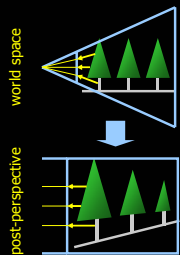
- Reeves et al., Siggraph '87:
 - "Percentage Closer Filtering"
- Tadamura et al., Visual Computer '01
 - "Plural Sunlight Depth Buffers"
- Fernando et al., Siggraph '01:
 - "Adaptive Shadow Maps"



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perspective transformation



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perspective shadow map

- standard shadow map
 - vertical yellow arrows pointing down to a perspective view of three green trees.
- perspective shadow map
 - vertical yellow arrows pointing down to a perspective view of three green trees, with a 'shadow map' label and a small image of the shadow map.

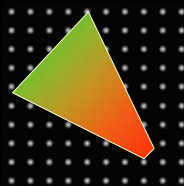


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perspective shadow map

- standard shadow map
 - a 2D grid of dots with a green triangle overlaid, showing aliasing artifacts.
- perspective shadow map
 - a solid orange square.



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perspective shadow map

- shadow map in post-perspective space
- just another shadow map projection
- reduces perspective aliasing
- regeneration per frame necessary

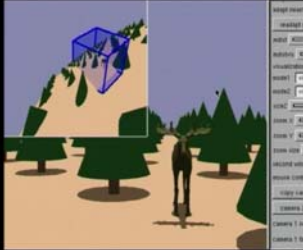


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light source transformation

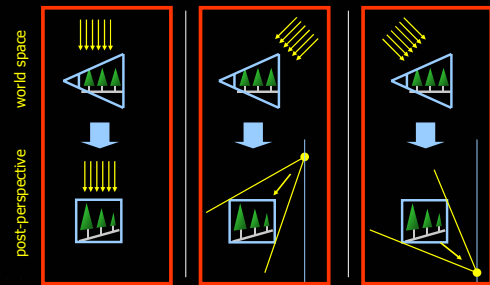
- parallel light becomes point light



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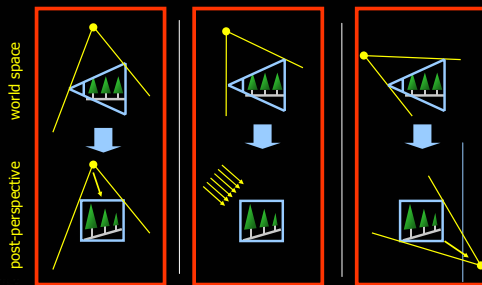
parallel light transformation



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point light transformation

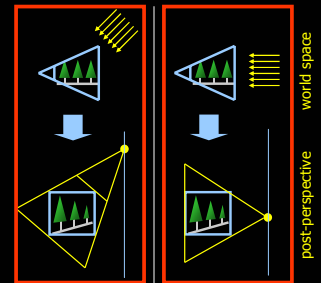


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discussion

- bad case:
 - point light close to frustum
- worst case
 - becomes uniform map

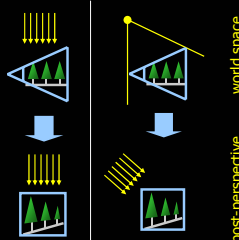


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discussion

- best case:
 - parallel light in post-perspective space
 - no new perspective distortion

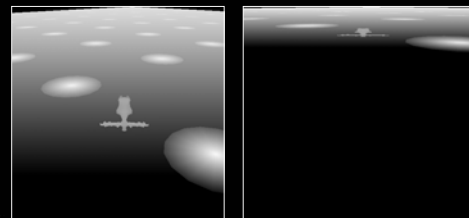


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near plane selection

- near plane as far as possible

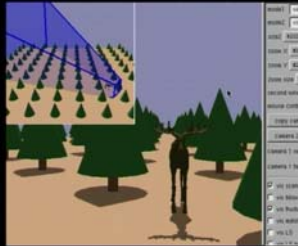


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near plane selection

- automatic selection: reading back depth buffer



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shadows from behind

- virtually move camera backwards

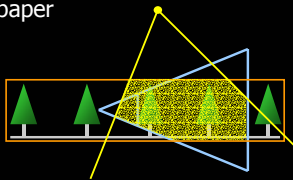


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shadow map window

- geometric method to include all necessary objects
 - details in the paper



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recorded directly off a
1 GHz PIII Compaq AP550 with a NVIDIA GeForce3

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results

- first implementation on an Xbox game developer kit



courtesy of Thatcher Ulrich

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conclusion

- perspective shadow maps
 - shadow map in post-perspective space
 - just another shadow map matrix
 - non-uniform shadow map resolution
 - needs recomputation per frame
 - minimal overhead for dynamic scenes

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acknowledgements

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- Frédo Durand



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thank you

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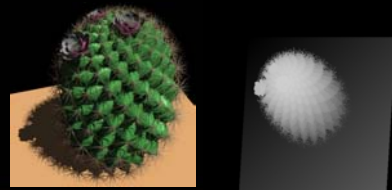


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shadow maps

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 - render scene from light source
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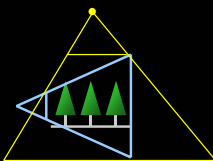
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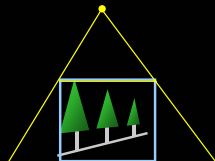
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idea

- uniform shadow map
- perspective shadow map



world space



post-perspective



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discussion

- ideal case
 - directional light parallel to image plane
 - miner's lamp
- worst case
 - parallel light from front or behind (becomes uniform shadow map)



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additional issues

- shadow map window
- camera near/far selection
- shadows from the back

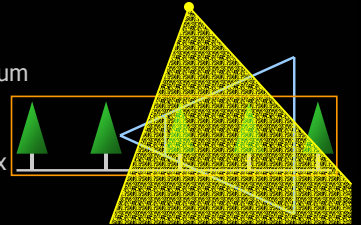


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shadow map window

- shadow map must contain:
 - light frustum
 - cut off by camera frustum
 - clipped by scene's bounding box

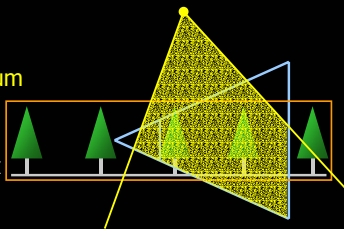


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